Answer on Question 55632, Physics, Molecular Physics | Thermodynamics

Question:

Determine the quantity of heat required to convert $1kg$ of ice at $-20℃$ to water at $100℃$? Specific heat capacities of water and ice water are $2302\frac{J}{kg\cdot K}$ and $4186\frac{J}{kg\cdot K}$ respectively.

Solution:

Let us calculate the quantity of heat that is needed to transform a $1kg$ of ice at $-20℃$ to water at $100℃$:

$$Q = Q_1 + Q_2 + Q_3,$$

where Q_1 is the amount of heat required to raise the temperature of ice from $-20℃$ to $0℃$, Q_2 is the latent heat required to change the state from ice at $0℃$ to water at $0℃$ and Q_3 is the amount of heat required to raise the temperature of water from $0℃$ to $100℃$.

$$Q_1 = m_{ice}c_{ice}\Delta t = 1kg \cdot 2302\frac{J}{kg \cdot K} \cdot (273.15K - 253.15K) = 46040J,$$

$Q_2 = m_{ice}L_f = 1kg \cdot 3.33 \cdot 10^5 \frac{J}{kg} = 333000J$ (Here, L_f is specific latent heat of water for fusion),

$$Q_3 = m_{water}c_{water}\Delta t = 1kg \cdot 4186\frac{J}{kg \cdot K} \cdot (373.15K - 273.15K) = 418600J.$$

$$Q = Q_1 + Q_2 + Q_3 = 46040J + 333000J + 418600J = 797640J.$$

Answer:

$Q = 797640J.$